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26OCT00 E578960-1 D01063
P01/7700 0.00-0026213.9

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1. Your reference — JSR.P51135GB

2. Patent [application number]
(The Pa[tent Office will fill in this part)]
0026213.9 — 25 OCT 2000

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Mitel Semiconductor Limited
Cheney manor
Swindon
Wiltshire, SN2 2QW

Patents ADP number *(if you know it)* — 7387442001

If the applicant is a corporate body, give the country/state of its incorporation — U.K.

4. Title of the invention — MODEM TUNER

5. Name of your agent *(if you have one)* — Marks & Clerk

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Marks & Clerk
4220 Nash Court
Oxford Business Park South
Oxford
OX4 2RU

Patents ADP number *(if you know it)* — 727 1125 001

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

Yes

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	(none)
Description	6
Claim*(s)*	2
Abstract	1 (Figure 3 suggested for Abstract)
Drawing*(s)*	2 + 08

10. If you are also filing any of the following, state how many against each item.

Priority documents	(none)
Translations of priority documents	(none)
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	1
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	(none)
Any other documents *(please specify)*	(none)

11. I/We request the grant of a patent on the basis of this application.

Signature
Marks & Clerk

Date
24 October, 2000

12. Name and daytime telephone number of person to contact in the United Kingdom — John Robinson 01865 397900

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Statement of inventorship and of right to grant of a patent

The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your reference

JSR.P51135GB

0026213.9

25 OCT 2000

3. Full name of the or of each applicant

Mitel Semiconductor Limited

4. Title of the invention

MODEM TUNER

5. State how the applicant*(s)* derived the right from the inventor*(s)* to be granted a patent

By virtue of employment of the inventors

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7. I/We believe that the person*(s)* named over the page *(and on any extra copies of this form)* is/are the inventor*(s)* of the invention which the above patent application relates to.

Signature — Date

Marks & Clerk — 24 October 2000

8. Name and daytime telephone number of person to contact in the United Kingdom

John Robinson 01865 397900

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Enter the full names, addresses and postcodes of the inventors in the boxes and underline the surnames

Nicholas Paul <u>Cowley</u>
3 Priors Hill
Wroughton
Wiltshire
SN4 0RT

1617722003

Patents ADP number *(if you know it)*:

Patents ADP number *(if you know it)*:

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Reminder

Have you signed the form?

MODEM TUNER

The present invention relates to a modem tuner. Such a tuner may be used for multi-mode modem applications, for example including cable systems, multi-point multi-channel distribution systems (MMDS) and local multi-point distribution service (LMDS).

Known types of modem tuners are based closely on cable standards, for example in terms of channel spacing, data rates and modulation schemes. Figure 1 of the accompanying drawings illustrates a typical known modem tuner of the single conversion type for receiving signals selectively from a satellite aerial 1 or a cable input 2. The satellite aerial is connected to a low noise block (LNB) 3, which receives signals, for example, in a band between 3GHz and 22GHz. The LNB 3 comprises a frequency changer which converts these frequencies into the L band between 900MHz and 2.2GHz. These signals are supplied to an in-door unit (IDU) 4, which converts the signals to be same frequency band as used by a cable distribution system to which the cable input 2 is connected, for example 50 to 900MHz. The output of the IDU 4 and the cable input 2 are connected to respective inputs of a multiplexer (MUX) 5, which selects which of the signal sources is connected to the input of a tuner 6.

The tuner input is connected to a tracking filter and automatic gain control (AGC) circuit 7. The output of the circuit 7 is connected to the signal input of a mixer 8, which receives a local oscillator signal from a local oscillator 9 controlled by a phase locked loop (PLL) synthesiser 10. The tuner 6 is of the single conversion type and the mixer 8 converts the selected channel, which may typically have a bandwidth of 8MHz, so that it is centred on the intermediate frequency, which is typically 44MHz. The intermediate frequency signal is supplied via a buffer 11 to a surface acoustic wave (SAW) intermediate frequency bandpass filter 12 which, for the example mentioned above, has a passband of 8MHz centred on a centre frequency of 44MHz. The output of the filter 12 is supplied via a buffer 13 to a circuit 14, which performs analogue/digital conversion, demodulation and forward error correction.

Figure 2 of the accompanying drawings illustrates an alternative type of tuner of the double conversion type. Like reference numerals refer to like parts in Figures 1 and 2 and such like parts will not be described again.

The tuner 6 of Figure 2 comprises an input AGC stage 15 whose output is connected to a first frequency changer comprising a mixer 8a connected to a local oscillator 9a controlled by a PLL synthesiser 10a. The first frequency changer converts the incoming signal selected by the multiplexer 5 to a relatively high intermediate frequency, for example 1.2GHz. This is filtered by a high intermediate frequency (IF) bandpass filter 16 and supplied to a second frequency changer comprising a mixer 8b connected to a local oscillator 9b controlled by a PLL synthesiser 10b. The second frequency changer converts the high IF signal to a second low intermediate frequency which is typically 44MHz. The second IF signal is then buffered and filtered before being supplied to the circuit 14 for conversion to and processing in the digital domain.

Known arrangements of the type shown in Figures 1 and 2 suffer from various disadvantages. For example, because the signals from the satellite aerial 1 are converted to the same frequency range as the signals from the cable distribution system, interactions may occur between signals from the two sources. For example, if the tuner 6 is set to receive a desired channel from one of the sources and a channel at the same frequency is present from the other source, interactions may occur between the two data streams carried by the signals so that the desired data stream suffers interference.

There are proposed new standards for transmission systems which require that channel bandwidths be variable and increased. Also, different data rates and types of modulation are being proposed in such standards. Modem tuners of the type shown in Figures 1 and 2 are not well-suited to meeting the requirements of the proposed new standards.

For example, higher image rejection in front of or within the mixer 8 or 8a will be required because, with wider channels, the wanted and image channels will be closer together. Also, the bandwidths of the tracking filter of the stage 7 or of the high IF filter

16 will need to be wider in order to cope with the wider channel bandwidths. This makes the image rejection problem worse and also allows more potentially interfering signals to be passed in the case where lower bandwidth channels are to be received. Thus, the potential for intermodulation distortion is increased. Providing bandpass filters of variable bandwidth for the filters 12 and 16 causes substantial problems and is impractical for tracking filters in the circuit 7 of the tuner shown in Figure 1. Thus, tuners of the type shown in Figures 1 and 2 are unlikely to provide satisfactory performance for the proposed new standards.

According to the invention, there is provided a modem tuner comprising a mixer for receiving data-modulated signals in any selected one of a plurality of different input frequency ranges, and a local oscillator having bandswitching for supplying to the mixer a local oscillator signal in any selected one of a plurality of local oscillator frequency ranges.

A first of the input frequency ranges may be substantially within a first band from 50 to 900MHz.

A second of the input frequency ranges may be substantially within a second band from 900MHz to 2.2GHz.

The number of input frequency ranges may be equal to the number of local oscillator frequency ranges. The mixer may have a signal input connected to a multiplexer for selectively connecting the signal input to any one of a plurality of tuner inputs in synchronism with the bandswitching of the local oscillator. Each of the tuner inputs may be connected to the multiplexer via a respective buffer.

The mixer and the local oscillator may comprise a zero intermediate frequency frequency changer. The tuner may comprise a variable bandwidth filter for filtering a zero intermediate frequency signal from the mixer. The filter may be a low-pass filter.

The mixer may have in-phase and quadrature outputs.

The present invention and various of its embodiments thus overcome or reduce many of the disadvantages of known modem tuners. For example, data streams from different sources are isolated in the frequency domain so that there is no or much reduced possibility of cross-contamination and interference.

It is possible to provide a tuner which is compatible with wired and wireless systems and with proposed extensions in flexible channel bandwidths and modulation schemes. Thus, it is easier to provide a universal modem arrangement.

It is possible to avoid the need for external IF gain stages and AGC circuits so as to provide a simpler arrangement. Supplying signals to the demodulator at baseband reduces the performance requirements on analogue/digital conversion. For example, the analogue bandwidth may be reduced to one tenth of that in known arrangements.

The use of zero intermediate frequency techniques means that there are no image frequencies to be taken into account. Also, the tuner may be simplified by not requiring any tracking components and by providing only one frequency conversion stage.

The invention will be further described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a block circuit diagram of a first known type of modem tuner;

Figure 2 is a block circuit diagram of a second known type of modem tuner; and

Figure 3 is a block circuit diagram of a modem tuner constituting an embodiment of the present invention.

Like reference numerals refer to like parts throughout the drawings and those parts which have been described hereinbefore will not be described further.

The modem tuner shown in Figure 3 comprises a cable input 2 connected to a diplexer 20 which is connected to a first input of the tuner 6 and to an upstream modulator 21. The modulator 21 may, for example, be embodied by the same hardware as the circuit 14 and supplies signals via the diplexer 20 to the cable input 2 for distribution via a cable distribution system.

The satellite aerial is connected to an LNB 3, which converts the incoming signal to the L band and supplies this via a diplexer 22 to a second input of the receiver 6. The diplexer 22 also receives signals from the modulator 21 for distribution.

The inputs of the tuner 6 are connected to respective buffers 23 and 24 whose outputs are connected to a multiplexer 5. The output of the multiplexer 5 is connected to a mixer 8 which converts the incoming signals to zero intermediate frequency in-phase (I) and quadrature (Q) signal paths. A local oscillator 9 controlled by a PLL synthesiser 10 is connected to the mixer 8 via a bandswitch 25, which supplies in-phase and quadrature local oscillator signals to the mixer 8. The outputs of the mixer 8 are supplied via buffering 11 to a variable bandwidth low-pass filter 26, whose outputs are supplied to the circuit 14 for analogue/digital conversion, demodulation and forward error correction.

Each input of the tuner 6 receives signals in a different frequency range. For example, signals from the cable input are typically in a frequency band between 50 and 900MHz. The frequency-converted signals from the LNB 3 are in the L band 900MHz to 2.2GHz. Thus, by ensuring that the different input signal sources are in different frequency ranges, the possibility of interference between signals at the different inputs is eliminated or substantially reduced.

The individual input signals are independently buffered by the buffers 23 and 24 before being selected by the multiplexer 5. The frequency ranges provided by the bandswitch 25 correspond to the different input frequency ranges at the different inputs and the bandswitch 25 and the multiplexer 5 are controlled together in synchronism. The filter 26 is embodied as a low-pass filter whose bandwidth can therefore easily be varied in

order to cope with different channel widths for data streams. By converting the input signals to zero intermediate frequency, image problems are substantially avoided and the requirements of the analogue/digital conversion in the circuit 14 are greatly reduced by performing the conversion at baseband.

It is thus possible to provide a modem tuner of improved performance and reduced complexity and cost. Such a tuner is capable of receiving data streams of different standards, such as different channel bandwidths and different bit rates, from any of a variety of sources such as cable distribution systems, MMDS and LMDS. Tracking components can be eliminated and non-zero intermediate frequency bandwidth problems can be avoided.

CLAIMS:

1. A modem tuner comprising a mixer for receiving data-modulated signals in any selected one of a plurality of different mixer frequency ranges, and a local oscillator having bandswitching for supplying to the mixer a local oscillator signal in any selected one of a plurality of local oscillator frequency ranges.

2. A tuner as claimed in claim 1, in which a first of the input frequency ranges is substantially within a first band from 50 to 900MHz.

3. A tuner as claimed in claim 1 or 2, in which a second of the input frequency ranges is substantially within a second band from 900MHz to 2.2GHz.

4. A tuner as claimed in any one of the preceding claims, in which the number of input frequency ranges is equal to the number of local oscillator frequency ranges.

5. A tuner as claimed in claim 4, in which the mixer has a signal input connected to a multiplexer for selectively connecting the signal input to any one of a plurality of tuner inputs in synchronism with the bandswitching of the local oscillator.

6. A tuner as claimed in claim 5, in which each of the tuner inputs is connected to the multiplexer via a respective buffer.

7. A tuner as claimed in any one of the preceding claims, in which the mixer and the local oscillator comprise a zero intermediate frequency frequency changer.

8. A tuner as claimed in claim 7, comprising a variable bandwidth filter for filtering a zero intermediate frequency signal from the mixer.

9. A tuner as claimed in claim 8, in which the filter is a low-pass filter.

10. A tuner as claimed in any one of the preceding claims, in which the mixer has in-phase and quadrature outputs.

ABSTRACT

MODEM TUNER

(Figure 3)

A modem tuner comprises a mixer 8 which receives inputs via a multiplexer 5 in different frequency ranges from different sources such as cable 2 and satellite 1. A local oscillator 9 supplies signals via a bandswitch 25 which switches the local oscillator frequency range in synchronism with the selection of inputs by the multiplexer 5. The mixer 8 converts the selected incoming data stream to zero intermediate frequency and this signal is filtered by a variable bandwidth low-pass filter 26, which is converted to the digital domain and demodulated in a circuit 14.

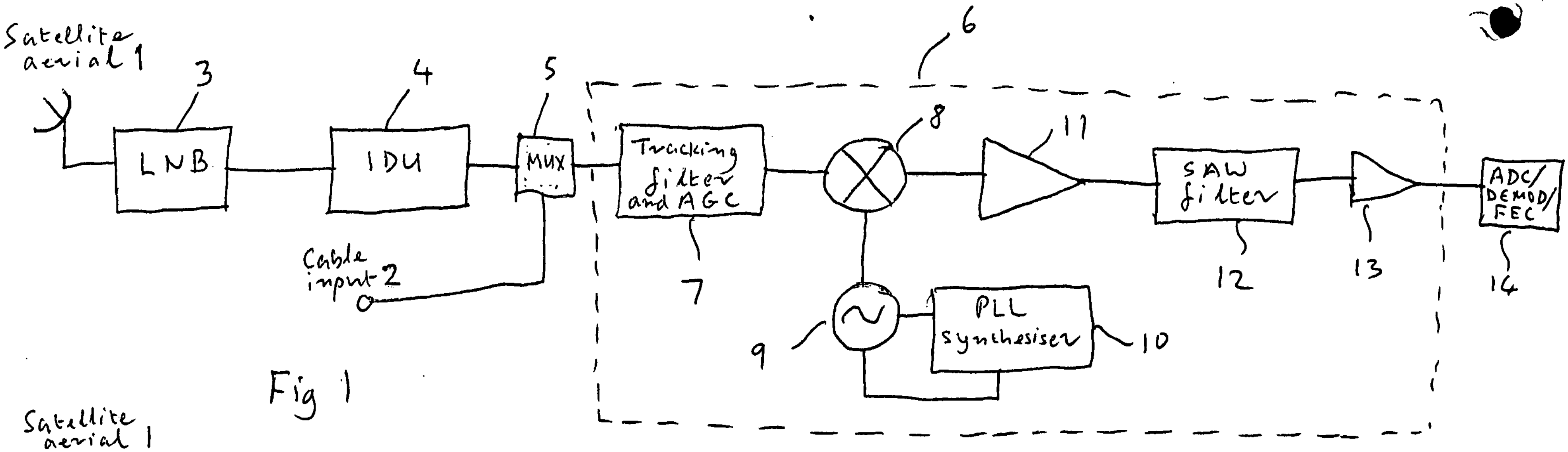
Satellite aerial 1
LNB
3
IDU
4
MUX
5
Cable input 2
6
Tracking filter and AGC
7
8
9
11
PLL synthesiser
10
SAW filter
12
13
ADC/ DEMOD/ FEC
14

Fig 1

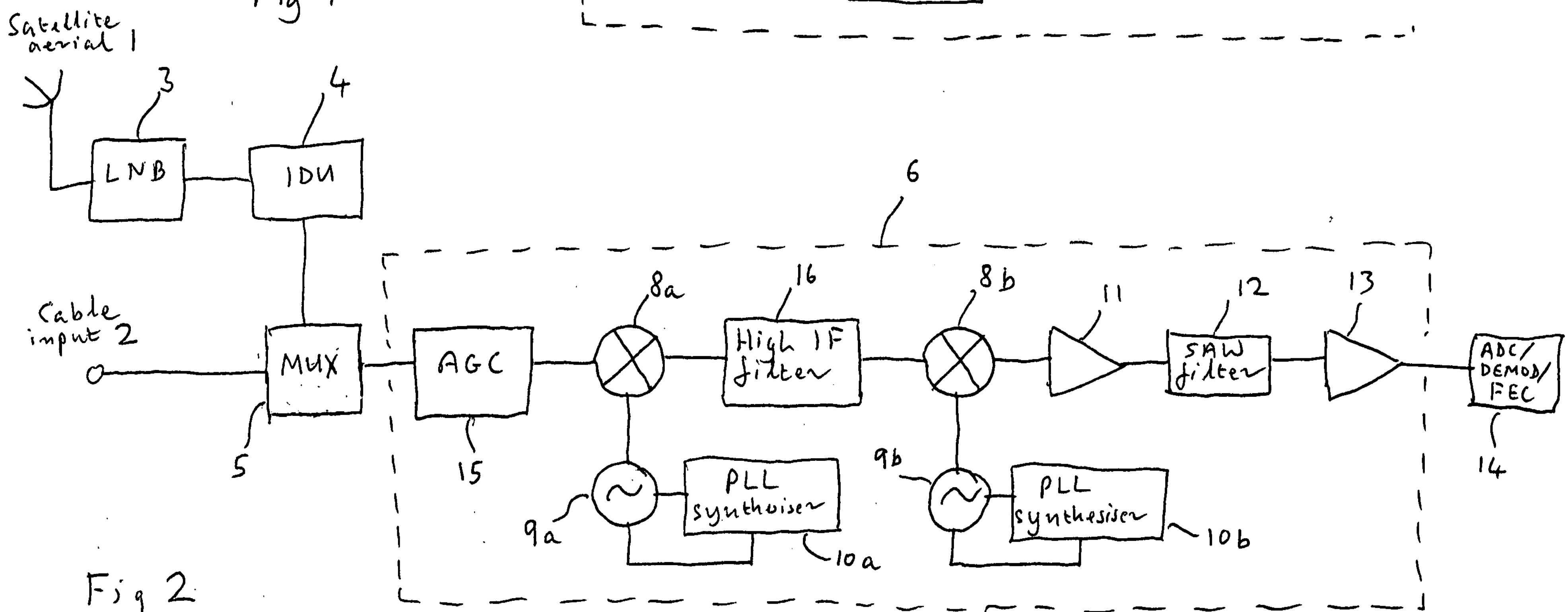
Satellite aerial 1
LNB
3
IDU
4
Cable input 2
MUX
5
6
AGC
15
8a
9a
PLL synthoiser
10a
High IF filter
16
8b
9b
PLL synthesiser
10b
11
SAW filter
12
13
ADC/ DEMOD/ FEC
14

Fig 2

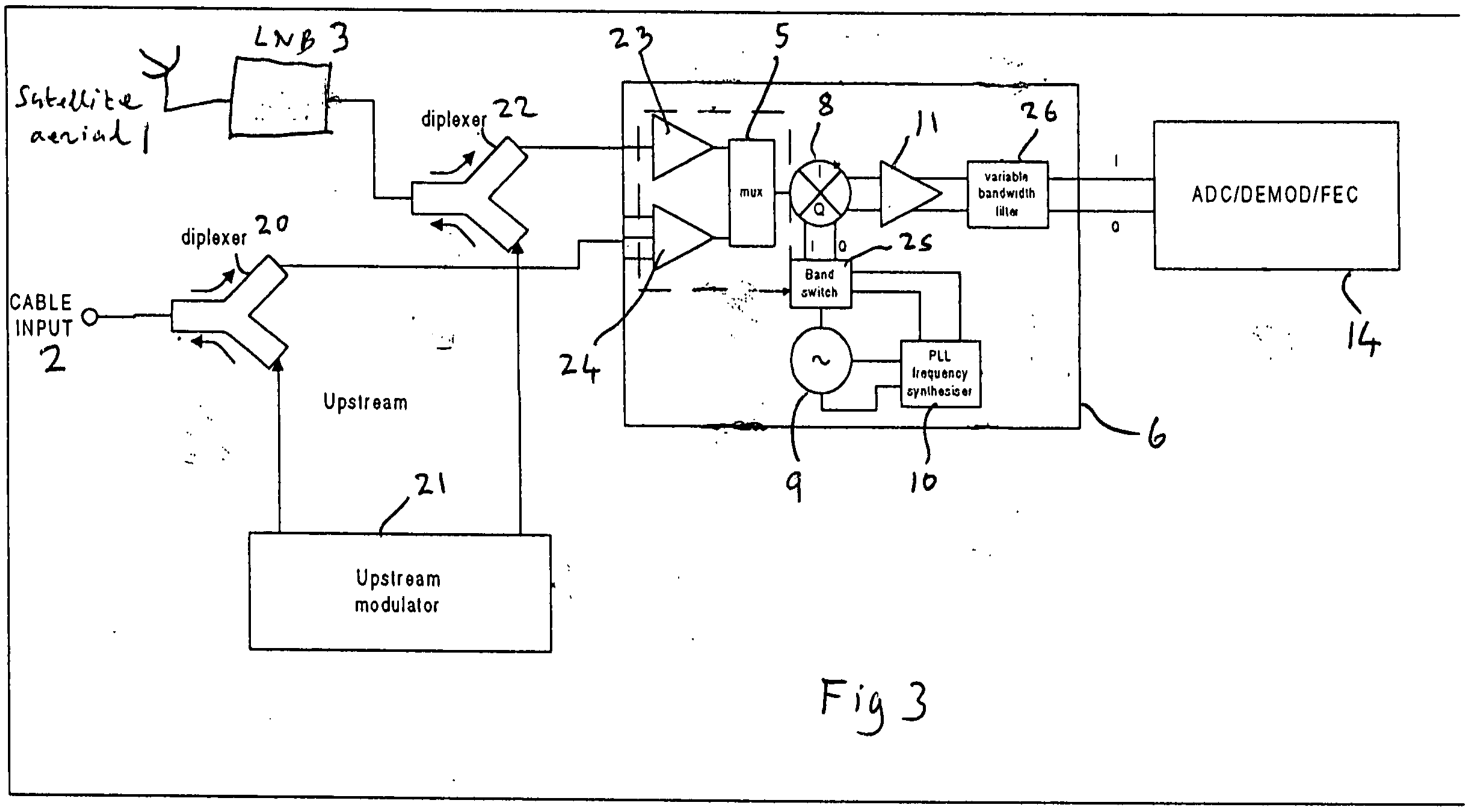
Satellite aerial 1
LNB 3
diplexer 22
diplexer 20
CABLE INPUT 2
Upstream
21
Upstream modulator
23
5
8
11
26
mux
variable bandwidth filter
Band switch
25
PLL frequency synthesiser
24
9
10
6
ADC/DEMOD/FEC
14

Fig 3

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